

Amendments to the Claims:

This listing of the claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

1 (Previously Presented): A perpendicular magnetic recording medium, comprising:

(a) a non-magnetic substrate having a surface; and

(b) a layer stack formed over said substrate surface, said layer stack comprising, in overlying sequence from said substrate surface:

(i) a magnetically soft underlayer;

(ii) an interlayer structure for crystallographically orienting a

layer of a perpendicular magnetic recording material formed thereon; and

(iii) at least one crystallographically oriented magnetically hard perpendicular recording layer;

wherein said interlayer structure comprises, in overlying sequence from a surface of said magnetically soft underlayer:

(1) a first crystalline interlayer of a non-magnetic material formed in a gas atmosphere at a first pressure; and

(2) a second crystalline interlayer of a non-magnetic material formed in a gas atmosphere at a second pressure greater than said first pressure,

each of said first and said second crystalline interlayers comprises a non-magnetic material selected from the group consisting of Ru, RuCr, other Ru-based alloys, CoCrRu, Ti, CoCr, CoCrPt, CoCrTa, and CoCrMo, and

wherein said interlayer structure provides said magnetically hard perpendicular magnetic recording layer formed thereon with a hexagonal close-packed crystal lattice with a <0002> out-of-plane growth orientation.

2 (Previously Presented): The medium according to claim 1, wherein:

said magnetically soft underlayer comprises at least one magnetic material selected from the group consisting of: NiFe (Permalloy), NiFeNb, CoZr, CoZrTa, CoZrCr, CoZrNb, CoFe, Fe, FeN, FeSiAl, FeAlN, FeSiAlN, FeCoC, FeCoB, FeTaN, FeTaC, FeCoTaZr, and a laminated structure comprised of a plurality of magnetic layers each comprised of at least one of the recited magnetic materials and spaced-apart by spacer layers each comprised of at least one material selected from the group consisting of Ta, C, and Si or antiferromagnetic coupling layers each comprised of at least one material selected from the group consisting of Ru and IrMn.

3 (Previously Presented): The medium according to claim 2, wherein:

said magnetically soft underlayer comprises FeCoB.

4 (Canceled)

5 (Canceled)

6 (Previously Presented): A perpendicular magnetic recording medium, comprising:

- (a) a non-magnetic substrate having a surface; and
- (b) a layer stack formed over said substrate surface, said layer stack comprising, in overlying sequence from said substrate surface:
 - (i) a magnetically soft underlayer;
 - (ii) an interlayer structure for crystallographically orienting a layer of a perpendicular magnetic recording material formed thereon; and

(iii) at least one crystallographically oriented magnetically hard perpendicular recording layer;
wherein said interlayer structure comprises, in overlying sequence from a surface of said magnetically soft underlayer:

(1) a first crystalline interlayer of a non-magnetic material formed in a gas atmosphere at a first pressure; and
(2) a second crystalline interlayer of a non-magnetic material formed in a gas atmosphere at a second pressure greater than said first pressure,
each of said first and said second crystalline interlayers comprises a non-magnetic material selected from the group consisting of Ru, RuCr, other Ru-based alloys, CoCrRu, Ti, CoCr, CoCrPt, CoCrTa, and CoCrMo, and
adjacent grains of the second crystalline interlayer are physically separated.

7 (Previously Presented): The medium according to claim 1, wherein:
adjacent grains of said at least one magnetically hard perpendicular recording layer are physically separated.

8 (Original): The medium according to claim 7, wherein:
said at least one magnetically hard perpendicular recording layer comprises at least one magnetic material selected from the group consisting of: (1) Co-based magnetic alloys including one or more elements selected from the group consisting of Cr, Fe, Ta, Ni, Mo, Pt, V, Nb, Ge, Si, Al, B, Ti, Zr, Hf, and Pd; (2) oxides of said Co-based magnetic alloys; (3) iron nitrides, and (4) iron oxides.

9 (Original): The medium according to claim 1, wherein said layer stack further comprises:

(iv) an amorphous or crystalline seed layer between said magnetically soft underlayer and said interlayer structure.

10 (Original): The medium according to claim 9, wherein:
said amorphous or crystalline seed layer comprises at least one material selected from the group consisting of: Ta, Au, Cu, Pd, TiCr, Pt, and Ag.

11 (Original): The medium according to claim 1, wherein said layer stack further comprises:

(v) an adhesion layer in overlying contact with said substrate surface.

12 (Original): The medium according to claim 11, wherein said adhesion layer comprises at least one material selected from the group consisting of: Cr, CrTi, Ti, and TiNb.

13 (Original): The medium according to claim 1, wherein said layer stack further comprises:

(vi) a protective overcoat layer on an outermost surface of said at least one magnetically hard perpendicular recording layer.

14 (Original): The medium according to claim 13, wherein said protective overcoat layer comprises a carbon (C)-containing material.

15-20 (Canceled)

21 (~~Withdrawn~~ Currently Amended): The method as in claim [[19]] 29, wherein step (b) comprises forming said layer stack such that:

said magnetically soft underlayer comprises at least one magnetic material selected from the group consisting of: NiFe (Permalloy), NiFeNb, CoZr, CoZrTa, CoZrCr, CoZrNb, CoFe, Fe,

FeN, FeSiAl, FeAlN, FeSiAIN, FeCoC, FeCoB, FeTaN, FeTaC, and FeCoTaZr, and a laminated structure comprised of a plurality of magnetic layers each comprised of at least one of the recited magnetic materials and spaced-apart by spacer layers each comprised of at least one material selected from the group consisting of Ta, C, and Si or anti-ferromagnetic coupling (AFC) layers each comprised of at least one material selected from the group consisting of Ru and IrMn;

~~said amorphous or crystalline seed layer comprises at least one material selected from the group consisting of: Ta, Au, Cu, Pd, TiCr, Pt, and Ag; and~~

said at least one magnetically hard perpendicular recording layer comprises at least one magnetic material selected from the group consisting of: (1) Co-based magnetic alloys including one or more elements selected from the group consisting of Cr, Fe, Ta, Ni, Mo, Pt, V, Nb, Ge, Si, Al, B, Ti, Zr, Hf, and Pd; (2) oxides of said Co-based magnetic alloys; (3) iron nitrides; (4) and iron oxides.

22 (~~Withdrawn~~ Currently Amended): The method as in claim [[19]] 29, wherein step (b) further comprises forming as part of said layer stack:

- (v) an adhesion layer in overlying contact with said substrate surface; and
- (vi) a protective overcoat layer on an outermost surface of said at least one magnetically hard perpendicular recording layer.

23 (Previously Presented): The medium according to claim 1, wherein said magnetically soft underlayer is sputter-deposited at a sufficiently large target-to-substrate spacing and a sufficiently low gas pressure selected to provide said underlayer with a smooth surface having a low average surface roughness Ra below about 0.3 nm, as measured by Atomic Force Microscopy (AFM).

24 (Previously Presented): The medium according to claim 1, wherein said first pressure is less than about 5 mTorr, and said second pressure is at least about 15 mTorr.

25 (Canceled)

26 (~~Withdrawn~~ Currently Amended): The method as in claim [[19]] 29, wherein said magnetically soft underlayer is formed by sputter deposition at a sufficiently large target-to-substrate spacing and a sufficiently low gas pressure selected to provide said underlayer with a smooth surface having a low average surface roughness Ra below about 0.3 nm, as measured by Atomic Force Microscopy (AFM).

27 (~~Withdrawn~~ Currently Amended): The method as in claim [[19]] 29, wherein said first pressure is less than about 5 mTorr, and said second pressure is at least about 15 mTorr.

28 (Canceled)

29 (New): A method of manufacturing a perpendicular magnetic recording medium, comprising steps of:

- (a) providing a non-magnetic substrate having a surface; and
 - (b) forming a layer stack over said substrate surface, said layer stack comprising, in overlying sequence from said substrate surface:
 - (i) a magnetically soft underlayer;
 - (ii) an interlayer structure for crystallographically orienting a layer of a perpendicular magnetic recording material formed thereon; and
 - (iii) at least one crystallographically oriented magnetically hard perpendicular recording layer;
- wherein:

said interlayer structure comprises sputter forming, in overlying sequence from a surface of said magnetically soft underlayer:

(1) a first crystalline interlayer of a non-magnetic material sputter-deposited in a gas atmosphere at a first pressure; and

(2) a second crystalline interlayer of a non-magnetic material sputter-deposited in a gas atmosphere at a second pressure greater than said first pressure,

each of said first and said second crystalline interlayers comprises a non-magnetic material selected from the group consisting of Ru, RuCr, other Ru-based alloys, CoCrRu, Ti, CoCr, CoCrPt, CoCrTa, and CoCrMo, and

step (b) comprises forming said second crystalline interlayer such that adjacent grains thereof are physically separated.

30 (New): The method as in claim 29, wherein step (b) further comprises forming an amorphous or crystalline seed layer between said magnetically soft underlayer and said interlayer structure.

31 (New): The method as in claim 30, wherein said amorphous or crystalline seed layer comprises at least one material selected from the group consisting of: Ta, Au, Cu, Pd, TiCr, Pt, and Ag.

32 (New): A method of manufacturing a perpendicular magnetic recording medium, comprising steps of:

(a) providing a non-magnetic substrate having a surface; and
(b) forming a layer stack over said substrate surface, said layer stack comprising, in overlying sequence from said substrate surface:

(i) a magnetically soft underlayer;

- (ii) an interlayer structure for crystallographically orienting a layer of a perpendicular magnetic recording material formed thereon; and
 - (iii) at least one crystallographically oriented magnetically hard perpendicular recording layer;
- wherein:
- said interlayer structure comprises sputter forming, in overlying sequence from a surface of said magnetically soft underlayer:
- (1) a first crystalline interlayer of a non-magnetic material sputter-deposited in a gas atmosphere at a first pressure; and
 - (2) a second crystalline interlayer of a non-magnetic material sputter-deposited in a gas atmosphere at a second pressure greater than said first pressure,
- each of said first and said second crystalline interlayers comprises a non-magnetic material selected from the group consisting of Ru, RuCr, other Ru-based alloys, CoCrRu, Ti, CoCr, CoCrPt, CoCrTa, and CoCrMo, and
- wherein said interlayer structure provides said magnetically hard perpendicular magnetic recording layer formed thereon with a hexagonal close-packed crystal lattice with a <0002> out-of-plane growth orientation.
- 33 (New): The perpendicular magnetic recording medium according to claim 6, wherein said magnetically soft underlayer is sputter deposited at a sufficiently large target-to-substrate spacing and a sufficiently low gas pressure selected to provide said underlayer with a smooth surface having a low average surface roughness Ra below about 0.3 nm, as measured by Atomic Force Microscopy (AFM).